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Sakai et al.

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(54) **EXHAUST PIPE STRUCTURE OF MOTORCYCLE**

(71) Applicant: **HONDA MOTOR CO., LTD.**, Tokyo (JP)

(72) Inventors: **Takeshi Sakai**, Wako (JP); **Satoshi Matsushima**, Wako (JP)

(73) Assignee: **HONDA MOTOR CO., LTD.**, Tokyo (JP)

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F01N 13/08	(2010.01)
F01N 13/18	(2010.01)
F02B 61/02	(2006.01)

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(58) **Field of Classification Search**

CPC .. F01N 13/002; F01N 13/1805; F01N 13/08; F01N 2340/04; F01N 2590/04; F02B 61/02

See application file for complete search history.

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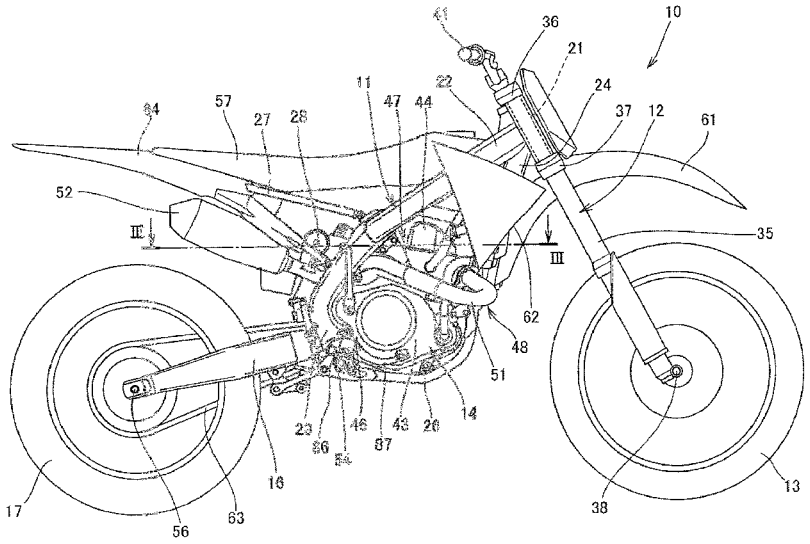
Primary Examiner — Audrey K Bradley

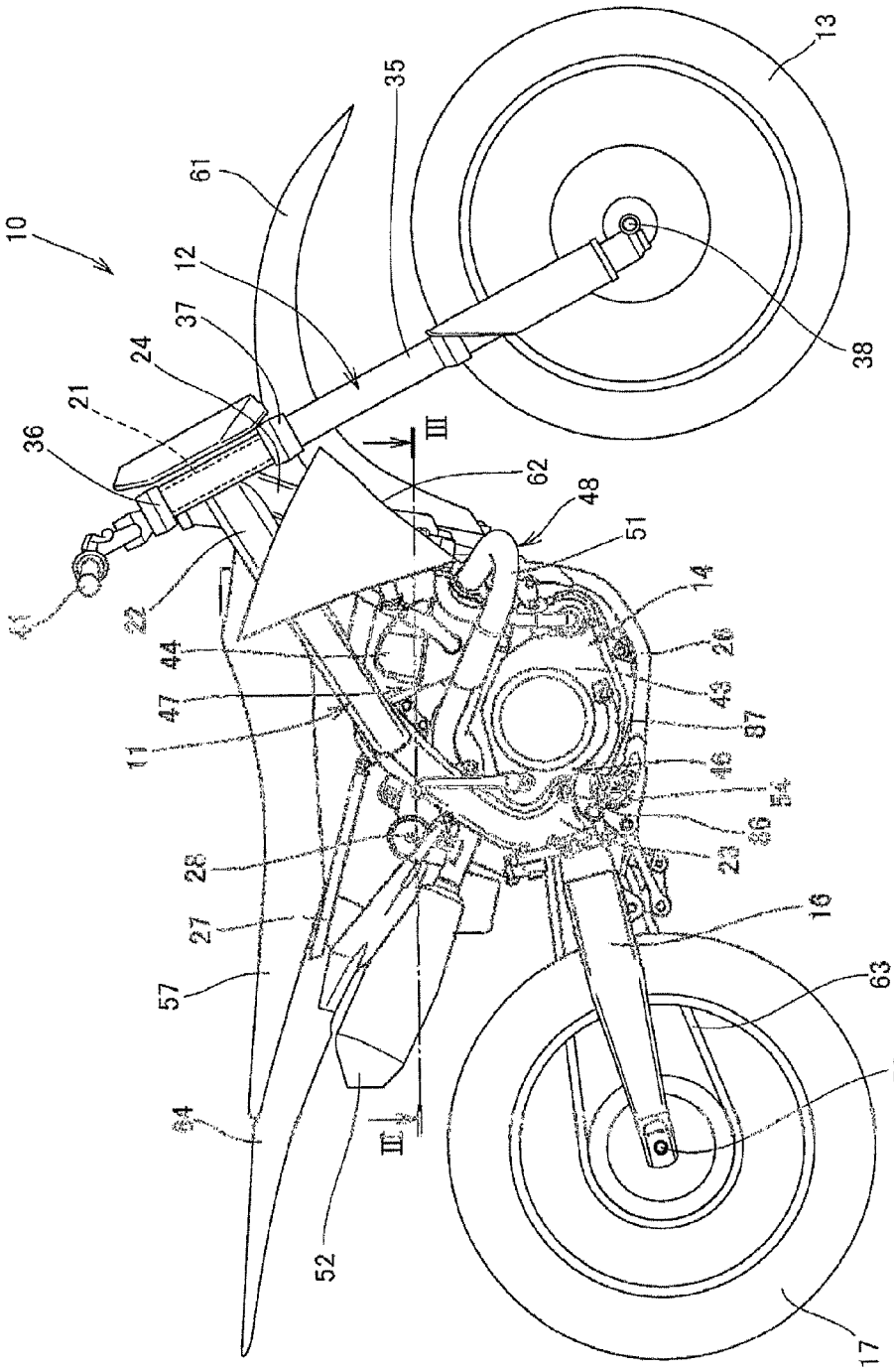
(74) *Attorney, Agent, or Firm* — Birch, Stewart, Kolasch & Birch, LLP

(57) **ABSTRACT**

An exhaust pipe structure of a motorcycle allowing exhaust air of an exhaust pipe having a branching part to flow into the respective exhaust pipes on the downstream side of the branching part uniformly and smoothly. In an exhaust pipe structure of a motorcycle having an engine attached to a vehicle body frame, an exhaust pipe is connected to an exhaust port of the engine and is provided with a branching pipe that branches into a left-rear-portion exhaust pipe and a right-rear-portion exhaust pipe. A muffler is connected to the left-rear-portion exhaust pipe. A muffler is connected to the right-rear-portion exhaust pipe. The branching pipe is located on a lateral side of a cylinder unit of the engine and above a crankcase cover.

16 Claims, 7 Drawing Sheets

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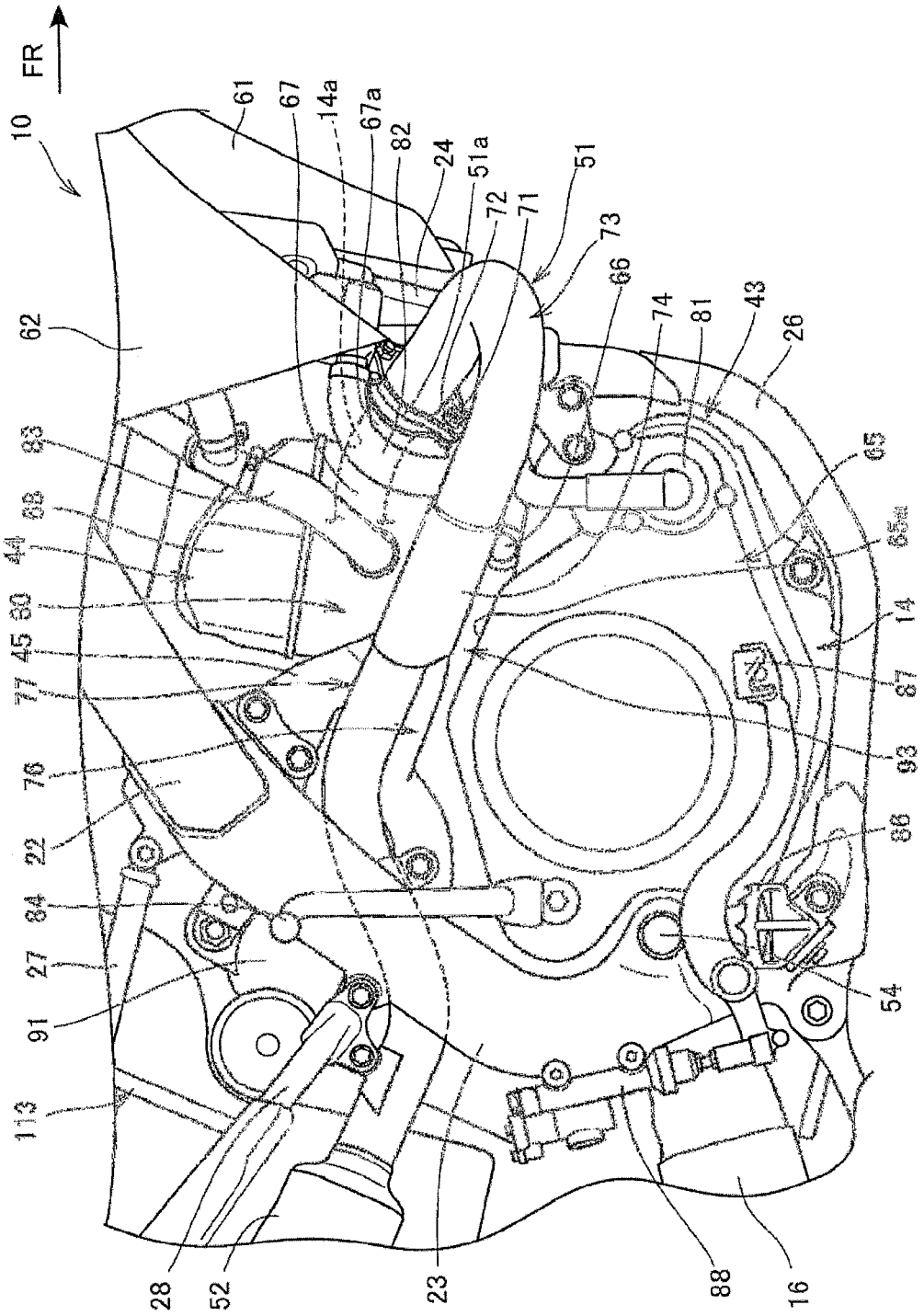
III
III

FIG. 1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88
44
80
45
77
76
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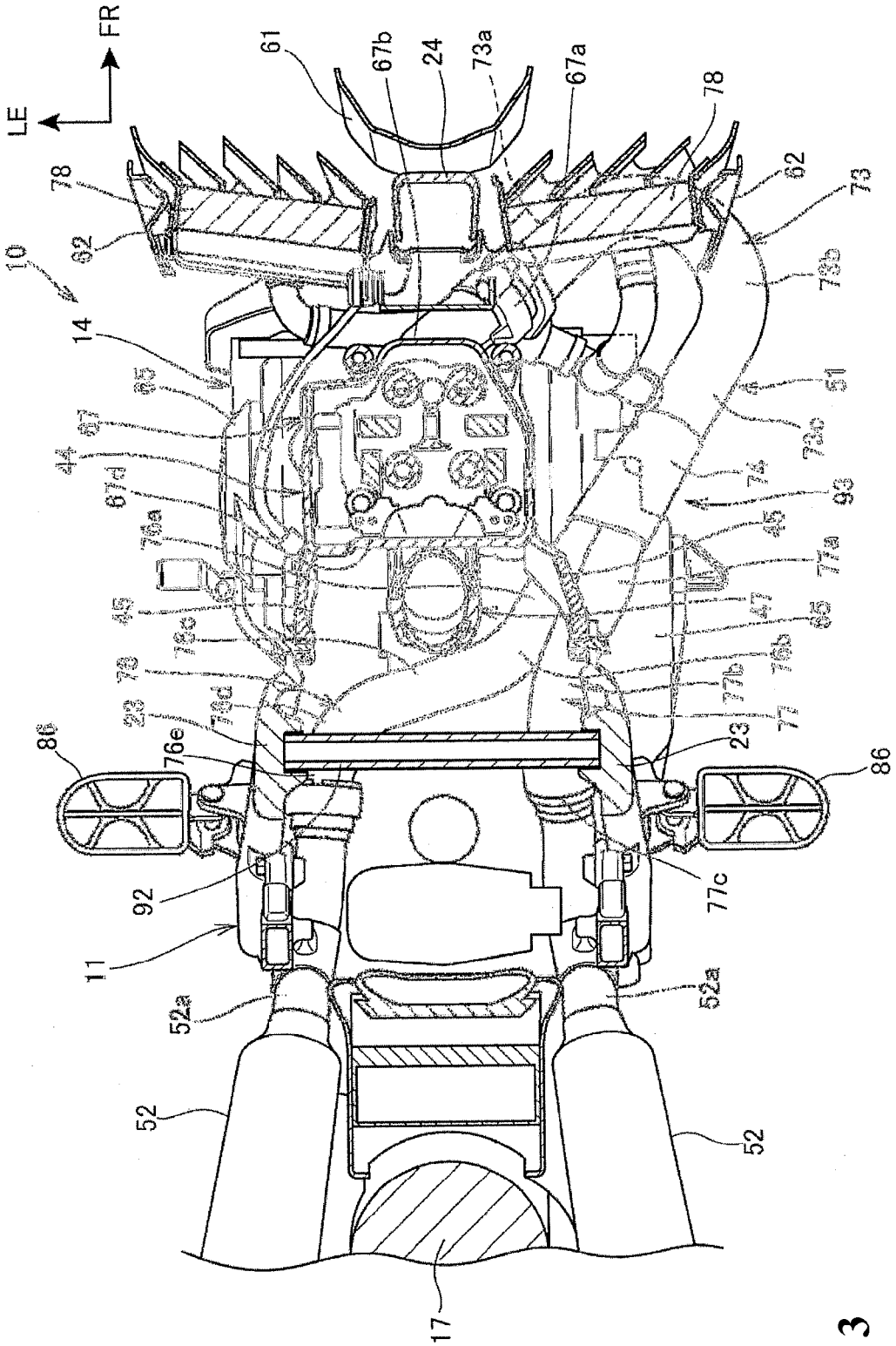
FIG. 2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14
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17
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44
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47
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52
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67
67a
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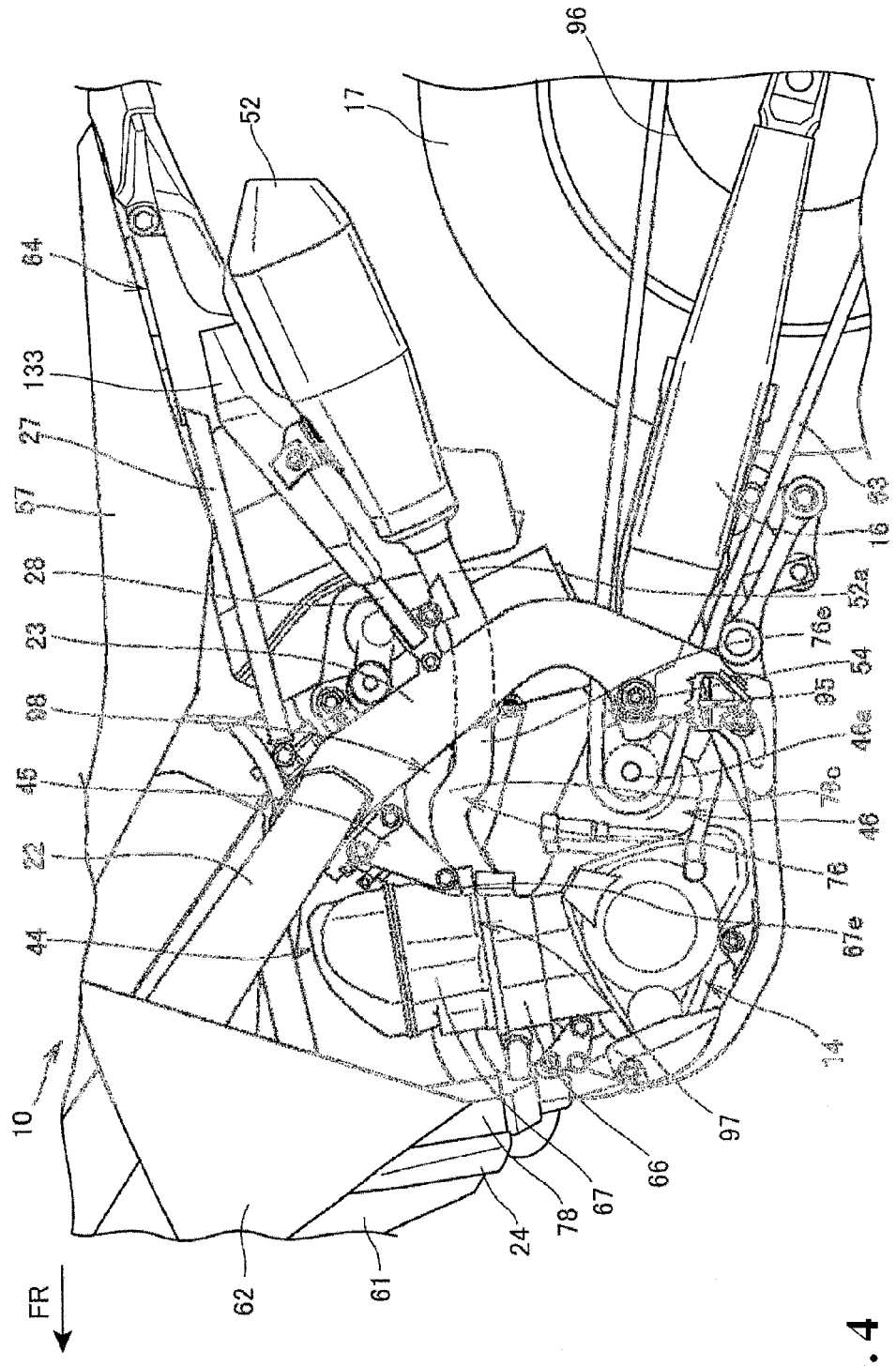
67d
70a
73
73a
73b
73c
74
76b
76c
76d
76e
77
77a
77b
77c
78
82
85
86
92
93

FIG. 3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133
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57
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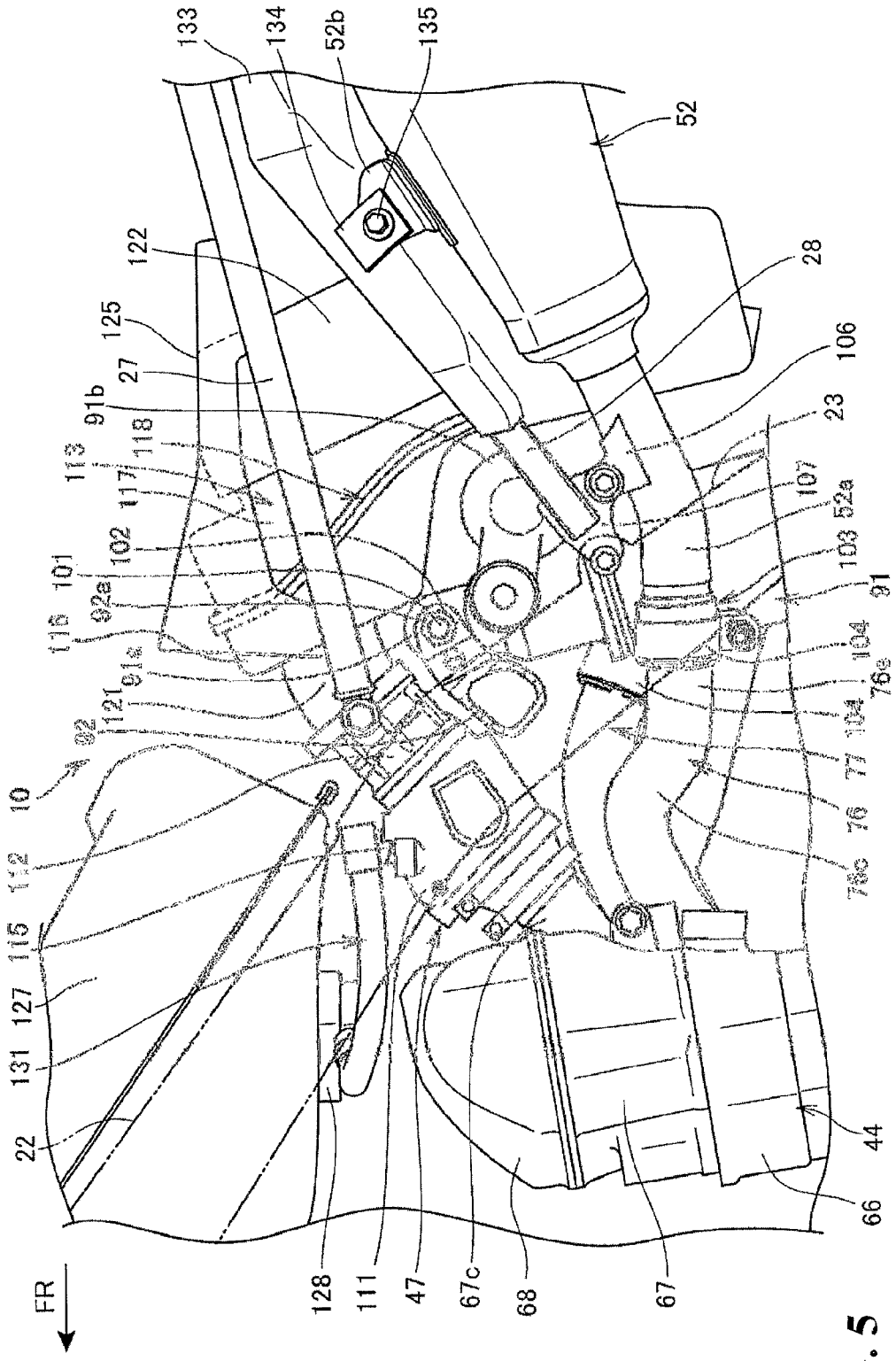
88
45
22
44
10
FR
62
61
24
78
67
66
97
14
67e
76
46
79c
46e
95
54
76e
52a
16
63

FIG. 4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10
112
115
127
131
22
106
23
107
52a
103
91
104
76e
104
77
76
76c
44
66
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128
111
47
67c
68
67

FIG. 5

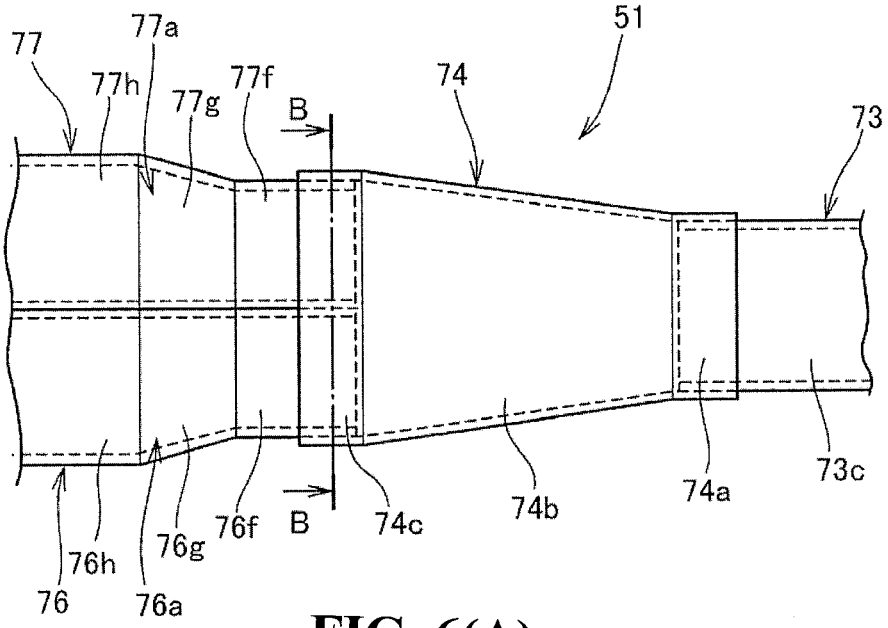

77
77a
77h
77g
77f
B
74
51
73
74a
73c
74b
74c
B
76f
76g
76h
76
76a

FIG. 6(A)

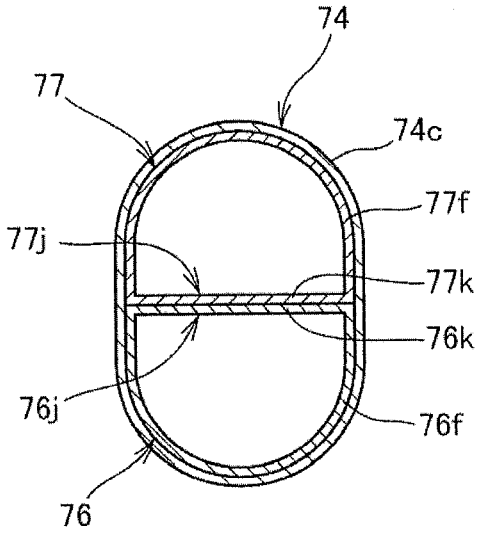
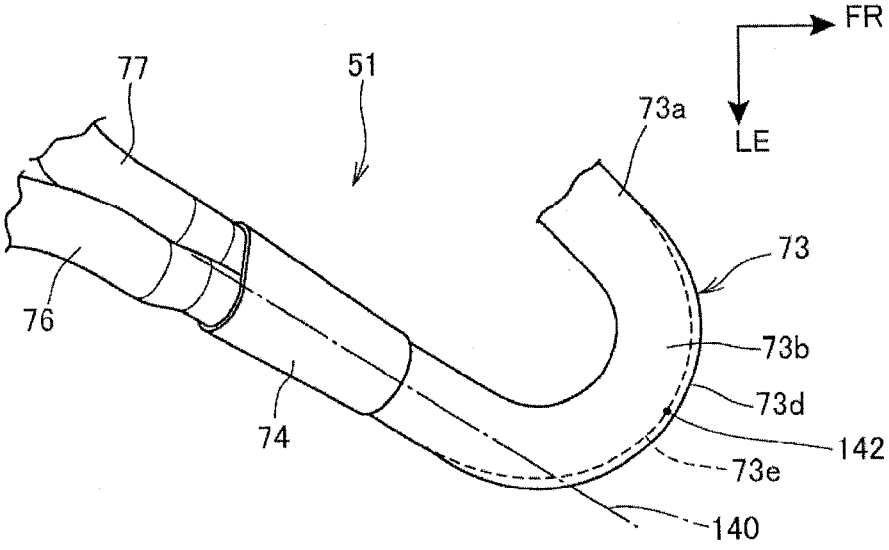

74
77
74c
77f
77j
77k
76k
76j
76f
76

FIG. 6(B)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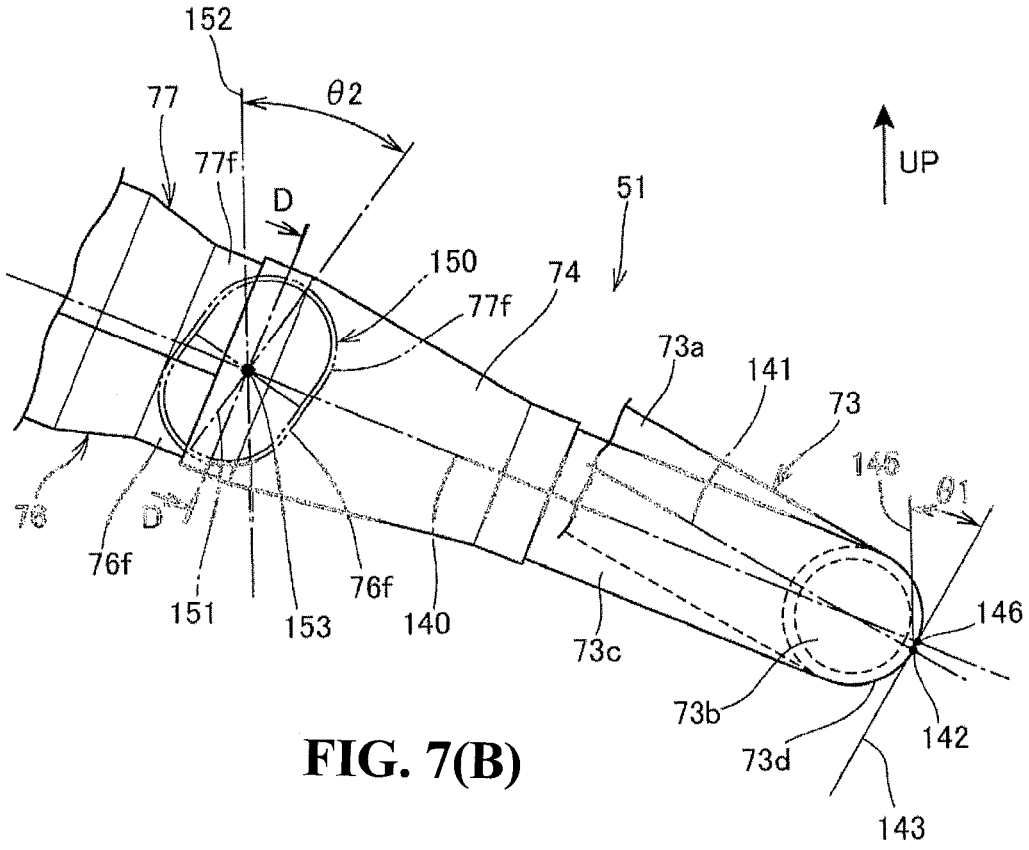
73a
73
76
73b
73d
74
142
73e
140

FIG. 7(A)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θ2
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77f
D
51
UP
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74
77f
73a
141
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145
θ1
76
76f
151
153
76f
140
73c
146
73b
142
73d
143

FIG. 7(B)

EXHAUST PIPE STRUCTURE OF MOTORCYCLE

CROSS-REFERENCE TO RELATED APPLICATIONS

The present application claims priority under 35 USC 119 to Japanese Patent Application No. 2014-057513 filed Mar. 20, 2014 the entire contents of which are hereby incorporated by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an exhaust pipe structure for a motorcycle wherein an exhaust pipe branches halfway.

2. Description of Background Art

A structure is known wherein an exhaust pipe, connected to an exhaust port of an internal combustion engine, is made to branch halfway and be connected to left and right mufflers. See, for example, Japanese Patent Laid-Open No. 2010-100224.

In Japanese Patent Laid-Open No. 2010-100224, the branching part of the exhaust pipe is provided on the rear side relative to a cylinder head of the internal combustion engine. Furthermore, on the immediate downstream side of the branching part, one exhaust pipe drastically curves in such a manner so as to avoid a rear shock absorber unit. In addition, the other exhaust pipe extends substantially on an extension of the exhaust pipe on the upstream side of the branching part. Therefore, in the one exhaust pipe, the exhaust flow is biased toward the outer circumferential side in the pipe and the airflow resistance increases, which suppresses the passing of the exhaust air. Accordingly, there is a problem that most of the exhaust air before the branching flows into the other exhaust pipe.

SUMMARY AND OBJECTS OF THE INVENTION

An object of an embodiment of the present invention is to provide an exhaust pipe structure of a motorcycle for allowing exhaust air of an exhaust pipe having a branching part to flow into the respective exhaust pipes on the downstream side of the branching part uniformly and smoothly.

In order to solve the above-described problem, according to an embodiment of the present invention, an exhaust pipe structure of a motorcycle having an internal combustion engine (**14**) is attached to a vehicle body frame (**11**). An exhaust pipe (**51**) is connected to an exhaust port (**14***a*) of the internal combustion engine (**14**) and is provided with a branching part (**74**) that branches into two branch exhaust pipes (**76**, **77**), and mufflers (**52**) each connected to a respective one of the branch exhaust pipes (**76**, **77**). The exhaust pipe structure of a motorcycle according to an embodiment of the present invention includes the branching part (**74**) that is located on a lateral side of a cylinder unit (**44**) of the internal combustion engine (**14**) and above a crankcase cover (**65**).

In the above configuration, the branching part (**74**) may branch in such a manner that the two branch exhaust pipes (**76**, **77**) are juxtaposed substantially in an upward-downward direction.

Furthermore, in the above configuration, the exhaust pipe (**51**) may extend from the exhaust port (**14***a*) toward a front side and then curve rearwardly at a curving part (**73***b*) and branch from the branching part (**74**) at a part further extending rearwardly. Furthermore, a section of the branching part (**74**) may be formed into a substantially elongated circular shape and a long axis (**151**) of the elongated circular shape may incline to be substantially parallel to a tangent plane (**143**) to a curving outer circumferential line (**73***e*) passing on an outermost circumference of the curving part (**73***b*) of the exhaust pipe (**51**).

Furthermore, in the above configuration, one of the branch exhaust pipes (**76**, **77**) may pass between a pivot plate (**23**) and a rear shock absorber (**91**) to extend rearwardly and be connected to one of the mufflers (**52**), and an other of the branch exhaust pipes (**76**, **77**) may pass between a rear side of the cylinder unit (**44**) and a front side of the rear shock absorber (**91**) and then pass between an other pivot plate (**23**) and the rear shock absorber (**91**) to extend rearwardly and be connected to an other of the mufflers (**52**).

In addition, in the above configuration, the branch exhaust pipes (**76**, **77**) may have at least one bending part (**76***b*, **76***d*, **77***b*) in a space that is on the rear side of the cylinder unit (**44**), on the front side of the rear shock absorber (**91**), above a crankcase (**43**), and below an intake system (**47**).

Moreover, in the above configuration, the branching part (**74**) and parts connected to front and rear of the branching part (**74**) in the exhaust pipe (**51**) may be formed into a linear part (**93**) having a linear shape and this linear part (**93**) may extend along an upper surface (**65***a*) of the crankcase cover (**65**) in side view.

According to an embodiment of the present invention, the branching part is located on a lateral side of the cylinder unit of the internal combustion engine and above the crankcase cover. Therefore, the branching part can be disposed closer to the vehicle body front side and near the center of the vehicle body. This can reduce the degree of bending of the branch exhaust pipes after the branching, which can provide a structure that reduces the airflow resistance to improve the passing of the exhaust air and makes the exhaust air flow into the respective branch exhaust pipes more uniformly. Accordingly, the exhaust air can be made to flow into the respective branch exhaust pipes more uniformly and smoothly.

Furthermore, according to an embodiment of the present invention, the branching part branches in such a manner so that the two branch exhaust pipes are juxtaposed substantially in the upward-downward direction. Thus, the branching part can be housed in a dead space on a lateral side of the cylinder unit and above the crankcase cover. This can reduce the degree of protrusion of the branching part in the vehicle width direction.

In addition, according to an embodiment of the present invention, the exhaust pipe extends from the exhaust port toward the front side and then curves rearwardly at the curving part and branches from the branching part at a part further extending rearwardly. Furthermore, a section of the branching part is formed into a substantially elongated circular shape and the long axis of the elongated circular shape inclines to be substantially parallel to the tangent plane to the curving outer circumferential line passing on the outermost circumference of the curving part of the exhaust pipe. Thus, the exhaust air flows with a bias toward the curving outer circumferential line. Therefore, by setting the long axis of the branching part substantially parallel to the tangent plane to the curving outer circumferential line, a flow conditioning effect can be achieved in the branching part and the exhaust air can be sent from the branching part to the two branch exhaust pipes more uniformly.

Moreover, one of the branch exhaust pipes passes between the pivot plate and the rear shock absorber to extend

rearwardly and be connected to one of the mufflers, and the other of the branch exhaust pipes passes between the rear side of the cylinder unit and the front side of the rear shock absorber and then passes between the other pivot plate and the rear shock absorber to extend rearwardly and be connected to the other of the mufflers. Thus, the bending of the branch exhaust pipes can be reduced and these pipes can be made linear. This can reduce the airflow resistance and improve the passing of the exhaust air.

Furthermore, according to an embodiment of the present invention, the branch exhaust pipes have at least one bending part in a space that is on the rear side of the cylinder unit, on the front side of the rear shock absorber, above the crankcase, and below the intake system. Therefore, the length of the exhaust pipe can be adjusted by providing the bending part by utilizing a dead space, and the flexibility in the design of the internal combustion engine can be increased.

In addition, according to an embodiment of the present invention, the branching part and parts connected to the front and rear of the branching part in the exhaust pipe are formed into the linear part having a linear shape and this linear part extends along the upper surface of the crankcase cover in side view. Thus, the length across which air in the exhaust passage is conditioned can be ensured by the linear part and the exhaust air that has passed in the branching pipe can be made to uniformly flow into the two branch exhaust pipes. Furthermore, by disposing the linear part along the upper surface of the crankcase cover, a space above the crankcase cover can be efficiently used.

Further scope of applicability of the present invention will become apparent from the detailed description given hereinafter. However, it should be understood that the detailed description and specific examples, while indicating preferred embodiments of the invention, are given by way of illustration only, since various changes and modifications within the spirit and scope of the invention will become apparent to those skilled in the art from this detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will become more fully understood from the detailed description given hereinbelow and the accompanying drawings which are given by way of illustration only, and thus are not limitative of the present invention, and wherein:

FIG. **1** is a right side view of a motorcycle including an exhaust pipe structure of one embodiment of the present invention;

FIG. **2** is a right side view of the major part of the motorcycle for showing the exhaust pipe structure;

FIG. **3** is a sectional view along line in FIG. **1**;

FIG. **4** is a left side view of the major part of the motorcycle for showing the exhaust pipe structure;

FIG. **5** is a left side view showing the major part of the motorcycle wherein a vehicle body frame is omitted;

FIGS. **6**(A) and **6**(B) are explanatory diagrams showing a branching pipe of an exhaust pipe and parts adjacent to the branching pipe. FIG. **6**(A) is a diagram showing the connection state of the respective parts of the exhaust pipe and FIG. **6**(B) is a sectional view along line B-B in FIG. **6**(A); and

FIGS. **7**(A) and **7**(B) are explanatory diagrams showing the front part of the exhaust pipe. FIG. **7**(A) is a plan view and FIG. **7**(B) is a diagram as viewed from the direction that is orthogonal to a branching pipe center line and is a horizontal direction.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

One embodiment of the present invention will be described below with reference to the drawings. In the description, directions such as front, rear, left, right, upward, and downward directions are the same as those with respect to the vehicle body unless particularly stated. Furthermore, as shown in the respective diagrams FR indicates the vehicle body front side. In addition, the vehicle body upper side UP and the vehicle body left side LE are provided.

FIG. **1** is a right side view of a motorcycle **10** including an exhaust pipe structure of one embodiment of the present invention.

The motorcycle **10** is a saddle-type vehicle having the following structure. A front wheel **13** is steerably supported by the front end part of a vehicle body frame **11** with the intermediary of a front fork **12** and an engine **14** being supported by the lower part of the vehicle body frame **11**. Furthermore, a rear wheel **17** is supported by the lower rear part of the vehicle body frame **11** with the intermediary of a swing arm **16**.

The vehicle body frame **11** includes a head pipe **21**, a pair of left and right main frames **22**, a pair of left and right pivot plates **23**, a down frame **24**, a pair of left and right under frames **26**, a pair of left and right seat rails **27**, and a pair of left and right sub-frames **28**.

The head pipe **21** forms the front end part of the vehicle body frame **11**. The main frames **22** extend from the head pipe **21** toward the rear side and the obliquely lower side on the left and right sides. The pivot plates **23** extend from the rear end parts of the left and right main frames **22** toward the lower side and the obliquely rear side and then toward the lower side and the obliquely front side. The down frame **24** extends from the attached part of the left and right main frames **22** to the head pipe **21** toward the lower side and the obliquely rear side. The under frames **26** extend from the lower end part of the down frame **24** toward the lower side on the left and right sides and extend rearwardly below the engine **14** to be joined to the pivot plates **23**. The seat rails **27** extend from the lower end parts of the main frames **22** toward the rear side and the obliquely upper side and their rear end parts are joined to the rear end parts of the sub-frames **28** extending from the pivot plates **23** toward the rear side and the obliquely upper side.

The front fork **12** is composed of a pair of left and right fork pipes **35**, a top bridge **36**, a bottom bridge **37**, and a steering stem (not shown). The fork pipes **35** are formed of shock absorbers and the front wheel **13** is supported by the lower end parts of the left and right fork pipes **35** with the intermediary of an axle **38**. The top bridge **36** and the bottom bridge **37** span the space between the left and right fork pipes **35** and a bar handle **41** is attached to the top bridge **36**. The steering stem is rotatably supported by the head pipe **21** and is vertically attached to the center of each of the top bridge **36** and the bottom bridge **37**.

The engine **14** is supported by the pivot plates **23**, the down frame **24**, and the under frames **26** and includes a crankcase **43** and a cylinder unit **44** extending upwardly from the upper front part of the crankcase **43**. An engine hanger **45** is attached to the upper end part of the pivot plate **23** in order to support the engine **14**.

A transmission **46** is integrally provided to the rear part of the crankcase **43**. Intake apparatus **47** is connected to the rear part of the cylinder unit **44** and exhaust apparatus **48** is connected to the front part. The exhaust apparatus **48** includes an exhaust pipe **51** that protrudes from the cylinder unit **44** toward the vehicle body right side to extend rearwardly with curving and branches to extend toward the left and right rear sides. A left and a right muffler **52**, respectively, are individually connected to the rear end part of the exhaust pipe **51**.

The swing arm **16** is supported vertically swingably by a pivot shaft **54** provided at the lower part of the pivot plate **23**. The rear wheel **17** is supported by its rear end part with the intermediary of an axle **56**. A seat **57** is supported by the upper parts of the main frames **22** and the seat rails **27**. A front fender **61** covers the front wheel **13** from above and a pair of left and right shrouds **62** cover the left and right lateral sides of the front part of the vehicle body frame **11**. In addition, a chain **63** transmits power from the transmission **46** to the rear wheel **17**. A rear fender **64** covers the rear wheel **17** from above.

FIG. **2** is a right side view of the major part of the motorcycle **10** for showing the exhaust pipe structure.

The crankcase **43** has a crankcase main body (not shown) disposed inside in the vehicle width direction and left and right crankcase covers **65** attached to both side parts of the crankcase main body.

The cylinder unit **44** of the engine **14** includes a cylinder block **66** attached to the upper front part of the crankcase **43**, a cylinder head **67** attached to the upper part of the cylinder block **66**, and a head cover **68** covering the upper part of the cylinder head **67**.

An exhaust pipe connecting part **67***a* is monolithically provided at the front part of the cylinder head **67**. The exhaust pipe connecting part **67***a* is a part at which an exhaust port **14***a* communicating with a combustion chamber is opened to the atmosphere. A flange part **51***a*, provided on the exhaust pipe **51**, is attached to the exhaust pipe connecting part **67***a* by a pair of bolts **71** and a pair of nuts **72** with the exhaust pipe **51** being connected to the exhaust port **14***a*.

The exhaust pipe **51** is composed of a front-portion exhaust pipe **73** that extends from the exhaust pipe connecting part **67***a* toward the front side and the obliquely right side and then curves rearwardly to further extend toward the rear side and the obliquely vehicle body inside, and two exhaust pipes connected to the front-portion exhaust pipe **73** with the intermediary of a branching pipe **74**, i.e. a left-rear-portion exhaust pipe **76** and a right-rear-portion exhaust pipe **77**. More specifically, the exhaust pipe **51** is made to branch from one pipe into two pipes by the branching pipe **74** and the left-rear-portion exhaust pipe **76** and the right-rear-portion exhaust pipe **77** are connected to the left and right mufflers **52**, respectively.

The branching pipe **74** is disposed close to the outside of the cylinder unit **44**, specifically the cylinder block **66** and the cylinder head **67**, in the vehicle width direction. Furthermore, the branching pipe **74** is disposed above the right crankcase cover **65**. That is, the branching pipe **74** and part of the front-portion exhaust pipe **73**, the left-rear-portion exhaust pipe **76**, and the right-rear-portion exhaust pipe **77**, which are connected to the front and rear of the branching pipe **74**, are disposed in a space **80** made on a lateral side of the cylinder unit **44** and above the crankcase cover **65**.

The front-portion exhaust pipe **73** extends from the exhaust pipe connecting part **67***a* toward the vehicle body outside with gradual lowering and curves rearwardly to thereafter extend toward the vehicle body inside with rising. The branching pipe **74** is inclined to extend toward the upper rear side in side view. Near the branching pipe **74**, the left-rear-portion exhaust pipe **76** and the right-rear-portion exhaust pipe **77** are inclined to extend toward the upper rear side in a side view. After the extension toward the upper rear side, the inclination of the right-rear-portion exhaust pipe **77** is changed and the right-rear-portion exhaust pipe **77** extends toward the lower rear side on the inside of the right pivot plate **23** in the vehicle width direction. Then, the right-rear-portion exhaust pipe **77** is inclined to extend toward the upper rear side again near the part connecting to the muffler **52**. The right-rear-portion exhaust pipe **77** is disposed so as to be higher than the left-rear-portion exhaust pipe **76** near the branching pipe **74**.

Inside the branching pipe **74** and the right-rear-portion exhaust pipe **77** (more specifically, right-rear-portion front end part **77***a*) in the vehicle width direction, the tip part of the engine hanger **45** and a supported part **67***e* (see FIG. **4**) integrally provided on a rear surface **67***d* of the cylinder head **67** in order to support the engine **14** by the engine hanger **45** are disposed. Therefore, the right-rear-portion exhaust pipe **77** passes through the outside of the engine hanger **45** in the vehicle width direction and passes through the inside of the pivot plate **23** in the vehicle width direction.

A water pump **81** is provided at the front part of the crankcase **43** with radiator lines **82** and **83**. Furthermore, a kick pedal **84** is provided on the transmission **46**. A step **86** is provided for the driver. In addition, a brake pedal **87** is provided with a master cylinder **88** linked to the brake pedal **87**.

FIG. **3** is a sectional view along line in FIG. **1**.

The exhaust pipe connecting part **67***a* is provided on the right side relative to a front surface **67***b* of the cylinder head **67**, more specifically relative to the center of the front surface **67***b* in the vehicle width direction.

The front-portion exhaust pipe **73** of the exhaust pipe **51** is monolithically composed of a front-portion front end part **73***a* extending from the exhaust pipe connecting part **67***a* toward the front side and the obliquely vehicle body outside, a front-portion curving part **73***b* that is formed so as to turn rearwardly from the front-portion front end part **73***a*, and a front-portion rear end part **73***c* extending from the rear end of the front-portion curving part **73***b* toward the rear side and the obliquely vehicle body inside. The foremost end part of the front-portion front end part **73***a* is located below a right radiator **78** of a pair of left and right radiators **78** disposed on the outside of the down frame **24** in the vehicle width direction.

The branching pipe **74** extends along the same direction as the front-portion rear end part **73***c* of the front-portion exhaust pipe **73**.

The left-rear-portion exhaust pipe **76** is monolithically composed of a left-rear-portion front end part **76***a* extending from the branching pipe **74** toward the rear side and the obliquely left side, a left-rear-portion middle part **76***c* that is connected to the left-rear-portion front end part **76***a* with the intermediary of a first bending part **76***b* and extends toward the left side and the obliquely rear side, and a left-rear-portion extending part **76***e* extending rearwardly from the left-rear-portion middle part **76***c* with the intermediary of a second bending part **76***d*.

The left-rear-portion front end part **76***a* is located below the engine hanger **45**. The first bending part **76***b* is located on the right side of the intake apparatus **47** connected to the rear part of the cylinder head **67**. The left-rear-portion middle part **76***c* passes in front of a rear shock absorber **91**

on the rear side of the intake apparatus **47**. The second bending part **76***d* is located at a part overlapping with, in plan view, a pipe-shaped crossing member **92** that joins the left and right pivot plates **23** to each other and extends along the vehicle width direction. The left-rear-portion extending part **76***e* passes between the left pivot plate **23** and the rear shock absorber **91** and is connected to a pipe part **52***a* provided at the front end part of the muffler **52**.

The crossing member **92** is disposed on the front side of the left and right steps **86** for the driver closely in the vehicle body front-rear direction.

The right-rear-portion exhaust pipe **77** is monolithically composed of the right-rear-portion front end part **77***a* extending from the branching pipe **74** toward the rear side and the obliquely left side and a right-rear-portion extending part **77***c* that is connected to the right-rear-portion front end part **77***a* with the intermediary of a bending part **77***b* and extends rearwardly. The right-rear-portion front end part **77***a* is located below the attached part of the engine hanger **45** to the right pivot plate **23** and the engine hanger **45**. The bending part **77***b* passes inside the right pivot plate **23** in the vehicle width direction. The right-rear-portion extending part **77***c* passes between the right pivot plate **23** and the rear shock absorber **91** and is connected to the pipe part **52***a* of the muffler **52**.

In the exhaust pipe **51** of the present embodiment, the front-portion rear end part **73***c* of the front-portion exhaust pipe **73**, the branching pipe **74**, the left-rear-portion front end part **76***a* of the left-rear-portion exhaust pipe **76**, and the right-rear-portion front end part **77***a* of the right-rear-portion exhaust pipe **77** form a linear part **93** having an almost straight line shape as is understood from the side view shown in FIG. **2** and the plan view shown in FIG. **3**. The linear part **93** is formed long to extend from the front surface **67***b* of the cylinder head **67** to a part on the rear side relative to the rear surface **67***d* of the cylinder head **67** (part at which the intake apparatus **47** bends upward) in the vehicle front-rear direction.

By forming the linear part **93** including the branching pipe **74** and ensuring the length of the linear part **93** in this manner, a structure providing the following advantages can be obtained. More specifically, the passage resistance can be reduced and the exhaust air flowing in the linear part **93** can be conditioned. Furthermore, it is easy to distribute the exhaust air into the left-rear-portion exhaust pipe **76** and the right-rear-portion exhaust pipe **77** more uniformly. Furthermore, in FIG. **2**, the linear part **93** extends toward the upper rear side along an upper surface **65***a* of the crankcase cover **65**. Therefore, the linear part **93** can be disposed close to the crankcase cover **65**. Accordingly, the space **80** above the crankcase cover **65** can be efficiently used.

FIG. **4** is a left side view of the major part of the motorcycle **10** for showing the exhaust pipe structure.

The left-rear-portion middle part **76***c* of the left-rear-portion exhaust pipe **76** is disposed above the transmission **46** in a side view, more specifically for example above an output shaft **46***a* of the transmission **46** and a drive sprocket **95** attached to the output shaft **46***a* in a side view.

The chain **63** is wound around the drive sprocket **95** together with a driven sprocket **96** provided integrally with the rear wheel **17** and power is transmitted from the drive sprocket **95** to the rear wheel **17** via the chain **63** and the driven sprocket **96**.

Furthermore, the left-rear-portion middle part **76***c* is disposed rearwardly of a joining part **97** between the cylinder block **66** and the cylinder head **67** in a side view. In this manner, the left-rear-portion middle part **76***c* as part of the left-rear-portion exhaust pipe **76** is disposed in a space **98** made above the transmission **46** provided to the rear part of the engine **14** and on the rear side of the cylinder unit **44**. The space **98** is surrounded by the engine **14**, the main frame **22**, and the pivot plate **23** in side view.

The left-rear-portion extending part **76***e* of the left-rear-portion exhaust pipe **76** and the pipe part **52***a* of the muffler **52** curve with such a large radius of curvature as to be downwardly convex from the side of the left-rear-portion middle part **76***c*. Therefore, the airflow resistance can be further reduced while the muffler **52** is disposed to extend toward the upper rear side.

FIG. **5** is a left side view showing the major part of the motorcycle **10** wherein the vehicle body frame is omitted.

The rear shock absorber **91** extends substantially along the upward-downward direction and its upper end part **91***a* is attached, by a bolt **101** and a nut **102**, to an upper shock absorber support part **92***a* protruding toward the upper side and the obliquely rear side from the center part of the crossing member **92**, which spans the space between the left and right pivot plates **23**, in the vehicle width direction. An oil reservoir tank **91***b* is integrally provided at the upper rear part of the rear shock absorber **91** and part of oil flowing in the rear shock absorber **91** is retained therein.

A rear-portion connecting part **103** that connects the left-rear-portion extending part **76***e* of the left-rear-portion exhaust pipe **76** to the pipe part **52***a* of the muffler **52** is provided on the left side of the rear shock absorber **91**. The rear-portion connecting part **103** is a part at which the rear end part of the left-rear-portion extending part **76***e* is fitted to the front end part of the pipe part **52***a*, and is tightened by a band member **104**.

A bracket **106** is attached to the upper part of the intermediate part of the pipe part **52***a*. A front end joint part **107** joined to the pivot plate **23** is provided at the front end part of the sub-frame **28** and the pipe part **52***a* is attached to the front end joint part **107** with the intermediary of the bracket **106**.

The intake apparatus **47** includes an intake pipe **67***c* provided integrally with the rear part of the cylinder head **67**, a throttle body **111** connected to the intake pipe **67***c*, and an air cleaner **113** connected to the rear end part of the throttle body **111** with the intermediary of a connecting tube **112**. As shown in the diagram, the intake apparatus **47** extends from the cylinder head **67** with such an inclination so as to extend toward the upper rear side.

A fuel injection valve **115** is attached to the upper part of the throttle body **111**. The air cleaner **113** includes an air cleaner case **118** composed of a front case **116** and a rear case **117** based on an anteroposteriorly-split structure, a case intake pipe part **121** provided on the front case **116** in such a manner so as to protrude toward the front side and the obliquely lower side. An air cleaner element **122** is provided at the rear part of the rear case **117**. The front end part of the case intake pipe part **121** is connected to the connecting tube **112**. An intake-side cover **125** surrounds the air cleaner **113** and is attached to the upper parts of the left and right seat rails **27**.

The left-rear-portion exhaust pipe **76** (more specifically, left-rear-portion middle part **76***c*) is disposed below the intake apparatus **47**, namely, the throttle body **111** and the connecting tube **112**.

A fuel tank **127** supported by the left and right main frames **22** is disposed above the cylinder unit **44**. A fuel pump **128** protruding to the inside of the fuel tank **127** is attached to the rear lower part of the fuel tank **127**. A fuel supply line **131** is connected to the fuel pump **128** and the

fuel injection valve **115** provided at the upper part of the throttle body **111**. A heat shield cover **133** blocks heat so that heat of the muffler **52** can be prevented from being transmitted to the side of the intake apparatus **47**. A muffler stay **134** is provided for attaching a muffler attachment part **52***b* provided at the upper part of the muffler **52** in order to support the muffler **52** to the sub-frame **28** by a bolt **135**.

FIGS. **6**(A) and **6**(B) are explanatory diagrams showing the branching pipe **74** of the exhaust pipe **51** and the parts adjacent to the branching pipe **74**. FIG. **6**(A) is a diagram showing the connection state of the respective parts of the exhaust pipe **51** and FIG. **6**(B) is a sectional view along line B-B in FIG. **6**(A).

As shown in FIG. **6**(A), the branching pipe **74** is monolithically composed of a front end pipe part **74***a*, a tapered pipe part **74***b*, and a rear end pipe part **74***c* in that order from the upstream side.

The front end pipe part **74***a* is connected by being fitted to the outside of the front-portion rear end part **73***c* of the front-portion exhaust pipe **73**. The end surface of the front end pipe part **74***a* is welded to the outer circumferential surface of the front-portion exhaust pipe **73**.

The rear end pipe part **74***c* is connected by being fitted to the outside of the left-rear-portion front end part **76***a* of the left-rear-portion exhaust pipe **76** and the right-rear-portion front end part **77***a* of the right-rear-portion exhaust pipe **77**. The end surface of the rear end pipe part **74***c* is welded to the respective outer circumferential surfaces of the left-rear-portion front end part **76***a* and the right-rear-portion front end part **77***a*.

The tapered pipe part **74***b* is a part linking the front end pipe part **74***a* and the rear end pipe part **74***c*.

The front end pipe part **74***a* has a circular tubular shape and the rear end pipe part **74***c* has a tubular shape with a section that is an elongated circle. The tapered pipe part **74***b* forms a shape with a diameter that gradually increases in the direction from the front end pipe part **74***a* toward the rear end pipe part **74***c* at least in the direction in which the left-rear-portion exhaust pipe **76** and the right-rear-portion exhaust pipe **77** are juxtaposed.

The left-rear-portion front end part **76***a* of the left-rear-portion exhaust pipe **76** monolithically includes a straight pipe part **76***f*, a tapered pipe part **76***g*, and a pipe part main body **76***h* in that order from the upstream side. Similarly, the right-rear-portion front end part **77***a* of the right-rear-portion exhaust pipe **77** monolithically includes a straight pipe part **77***f*, a tapered pipe part **77***g*, and a pipe part main body **77***h* in that order from the upstream side.

In the left-rear-portion front end part **76***a*, the straight pipe part **76***f* is a part inserted into the rear end pipe part **74***c* of the branching pipe **74**. The passage sectional area of the straight pipe part **76***f* is constant in its length direction and the section thereof forms a shape obtained by deforming a circular shape as described later. The tapered pipe part **76***g* is a part whose passage sectional area gradually increases in the direction from the rear end of the straight pipe part **76***f* toward the rear side. The pipe part main body **76***h* is a part linking to the rear end of the tapered pipe part **76***g* and its section forms a circular shape. Also in the right-rear-portion front end part **77***a*, its respective parts form shapes similar to those of the respective parts of the above-described left-rear-portion front end part **76***a*.

As shown in FIG. **6**(B), the straight pipe part **76***f* of the left-rear-portion exhaust pipe **76** and the straight pipe part **77***f* of the right-rear-portion exhaust pipe **77** are parts in each of which the section is formed into a semicircular shape obtained by partially deforming a circular shape. They are so welded so as to be fitted to the branching pipe **74**, whose section has an elongated circular shape, in a state in which flat bottom walls **76***j* and **77***j* as the bottoms of the semicircles, more specifically bottom surfaces **76***k* and **77***k* of the bottom walls **76***j* and **77***j*, are in contact with each other. The semicircular sections of the straight pipe parts **76***f* and **77***f* each have half of the shape of the elongated circular section.

By forming the section of each of the straight pipe parts **76***f* and **77***f* into the semicircular shape in this manner, the exhaust pipe **51** can be effectively disposed in a motorcycle with a small vehicle body space with suppression of forming of a useless space in the section of the connecting part compared with the case in which two exhaust pipes whose sections each have a circular shape are connected to the branching pipe **74**.

FIGS. **7**(A) and **7**(B) are explanatory diagrams showing the front part of the exhaust pipe **51**. FIG. **7**(A) is a plan view and FIG. **7**(B) is a diagram as viewed from the direction that is orthogonal to a branching pipe center line **140** and is a horizontal direction.

As shown in FIG. **7**(A), the front-portion curving part **73***b* exists at the lowest position in the front-portion exhaust pipe **73** and the height gradually increases as the front-portion exhaust pipe **73** extends from the front-portion curving part **73***b* toward the front-portion front end part **73***a* and toward the branching pipe **74**. Therefore, on an outer circumferential surface **73***d* of the front-portion curving part **73***b*, an outer circumferential line **73***e* remotest from the center of curvature of the front-portion curving part **73***b* is shown by a dashed line in the diagram.

As shown in FIG. **7**(B), in the front-portion exhaust pipe **73**, the front-portion front end part **73***a* is disposed at a higher level than the front-portion rear end part **73***c* and a front end part center line **141** passing through the center of the exhaust passage of the front-portion front end part **73***a* intersects the outer circumferential surface **73***d* at a point (tangent point) **142**. When a tangent plane **143** tangent to the outer circumferential surface **73***d* at the point **142** is drawn, the tangent plane **143** is inclined with respect to a vertical line **145** by an angle θ**1**. The branching pipe center line **140** passing through the center of each of the sections of the front-portion rear end part **73***c* and the branching pipe **74** intersects the outer circumferential surface **73***d* at a point **146**.

When a section along line D-D as a cross-section of the straight pipe part **76***f* of the left-rear-portion exhaust pipe **76** and the straight pipe part **77***f* of the right-rear-portion exhaust pipe **77** is drawn so as to overlap with the straight pipe parts **76***f* and **77***f*, a long axis **151** of an elongated circle **150** composed of the sections of the two straight pipe parts **76***f* and **77***f* is inclined with respect to a vertical line **152** by an angle θ**2** as shown in the diagram.

In the tangent plane **143**, the upper side relative to the point **142** is located closer to the outside in the vehicle width direction than the lower side relative to the point **142**. Furthermore, in the long axis **151** of the elongated circle **150**, the upper side relative to a center point **153** of the elongated circle **150** is located closer to the outside in the vehicle width direction than the lower side relative to the center point **153**.

As above, the tangent plane **143** accords with the long axis **151** in that the upper side is located outside in the vehicle width direction relative to the lower side. In fact, the tangent plane **143** is different from the long axis **151** in the inclination direction. However, when they are drawn with the inclination directions set identical to each other as shown

in the diagram, the tangent plane **143** is substantially parallel to the long axis **151** because the angle θ1 is substantially equal to the angle θ2.

As described above, in the front-portion exhaust pipe **73**, the inclination angle is larger in the part from the front-portion front end part **73***a* to the front-portion curving part **73***b* than in the part from the front-portion curving part **73***b* to the front-portion rear end part **73***c*. Therefore, exhaust air (exhaust gas) flowing from the front-portion front end part **73***a* to the front-portion curving part **73***b* collects more readily around the point **142** than around the point **146** at the front-portion curving part **73***b* due to the influence of the centrifugal force. Thus, in the front-portion rear end part **73***c* and the branching pipe **74**, which are on the downstream side relative to the front-portion curving part **73***b*, the flow of the exhaust air is larger on the lower side relative to the branching pipe center line **140**. In view of this, by inclining the elongated circle **150** of the left-rear-portion exhaust pipe **76** and the right-rear-portion exhaust pipe **77** as described above, the position of the straight pipe part **77***f* of the right-rear-portion exhaust pipe **77** located on the upper side is lowered and the position of the straight pipe part **76***f* of the left-rear-portion exhaust pipe **76** is raised. As a result, the flow of the exhaust air into the two straight pipe parts **76***f* and **77***f* can be made more uniform.

As shown in FIGS. **1**, **2**, and **3**, in the exhaust pipe structure of the motorcycle **10** having the engine **14** as an internal combustion engine attached to the vehicle body frame **11**, the exhaust pipe **51** that is connected to the exhaust port **14***a* of this engine **14** and is provided with the branching pipe **74** as a branching part that branches into the left-rear-portion exhaust pipe **76** and the right-rear-portion exhaust pipe **77** as two branch exhaust pipes. The mufflers **52** are each connected to a respective one of the left-rear-portion exhaust pipe **76** and the right-rear-portion exhaust pipe **77**. The branching pipe **74** is located on a lateral side of the cylinder unit **44** of the engine **14** and above the crankcase cover **65**.

According to this configuration, the branching pipe **74** can be disposed closer to the vehicle body front side and near the center of the vehicle body width. This can reduce the degree of bending of the left-rear-portion exhaust pipe **76** and the right-rear-portion exhaust pipe **77** after the branching, which can provide a structure that reduces the airflow resistance to improve the passing of the exhaust air and makes the exhaust air flow into the left-rear-portion exhaust pipe **76** and the right-rear-portion exhaust pipe **77** more uniformly. Accordingly, the exhaust air can be made to flow into the left-rear-portion exhaust pipe **76** and the right-rear-portion exhaust pipe **77** more uniformly and smoothly.

Furthermore, the branching pipe **74** branches in such a manner so that the left-rear-portion exhaust pipe **76** and the right-rear-portion exhaust pipe **77** are substantially juxtaposed in the upward-downward direction. Thus, the branching pipe **74** can be housed in a dead space on a lateral side of the cylinder unit **44** and above the crankcase cover **65**. This can reduce the degree of protrusion of the branching pipe **74** in the vehicle width direction.

In addition, as shown in FIGS. **1**, **2**, **3**, **7**(A), and **7**(B), the exhaust pipe **51** extends from the exhaust port **14***a* toward the front side and the obliquely right side and then curves rearwardly at the front-portion curving part **73***b* as a curving part and branches from the branching pipe **74** at a part further extending toward the rear side and the obliquely left side. The section of the branching pipe **74** is formed into a substantially elongated circular shape and the long axis **151** of the elongated circular shape inclines to be substantially parallel to the tangent plane **143** to the outer circumferential line **73***e* as a curving outer circumferential line passing on the outermost circumference of the front-portion curving part **73***b* of the exhaust pipe **51**. Thus, the exhaust air flows with a bias toward the outer circumferential line **73***e*. Therefore, by setting the long axis **151** of the branching pipe **74** substantially parallel to the tangent plane **143** to the outer circumferential line **73***e*, a flow conditioning effect can be achieved in the branching pipe **74** and the exhaust air can be sent from the branching pipe **74** to the left-rear-portion exhaust pipe **76** and the right-rear-portion exhaust pipe **77** more uniformly.

Moreover, as shown in FIGS. **6**(A) and **6**(B), the outer circumferential parts of the upstream end parts of the left-rear-portion exhaust pipe **76** and the right-rear-portion exhaust pipe **77** are partially deformed to form the bottom surfaces **76***k* and **77***k* as flat surfaces. The left-rear-portion exhaust pipe **76** and the right-rear-portion exhaust pipe **77** are fitted into the branching pipe **74** with these bottom surfaces **76***k* and **77***k* made to overlap with each other. Thus, the part of the bottom surfaces **76***k* and **77***k* plays a role of a flow conditioning plate, which allows the exhaust air to be uniformly distributed into the left-rear-portion exhaust pipe **76** and the right-rear-portion exhaust pipe **77**.

Furthermore, as shown in FIG. **3**, one of the left-rear-portion exhaust pipe **76** and the right-rear-portion exhaust pipe **77** passes between the pivot plate **23** and the rear shock absorber **91** to extend rearwardly and be connected to one of the mufflers **52**. The other of the pipes **76** and **77** passes between the rear side of the cylinder unit **44** and the front side of the rear shock absorber **91** and then passes between the other pivot plate **23** and the rear shock absorber **91** to extend rearwardly and be connected to the other of the mufflers **52**. Thus, the bending of the left-rear-portion exhaust pipe **76** and the right-rear-portion exhaust pipe **77** is reduced and these pipes are made linear. This can reduce the airflow resistance and improve the passing of the exhaust air.

In addition, as shown in FIGS. **2** and **3**, the left-rear-portion exhaust pipe **76** and the right-rear-portion exhaust pipe **77** have the first bending part **76***b*, the second bending part **76***d*, and the bending part **77***b* as at least one bending part in a space that is on the rear side of the cylinder unit **44**, on the front side of the rear shock absorber **91**, above the crankcase **43**, and below the intake apparatus **47** as an intake system. Therefore, the length of the exhaust pipe can be adjusted by providing the first bending part **76***b*, the second bending part **76***d*, and the bending part **77***b* by utilizing a dead space. Thus, the flexibility in the design of the engine **14** can be increased.

Moreover, the branching pipe **74** and the parts connected to the front and rear of the branching pipe **74** in the exhaust pipe **51** are formed into the linear part **93** having a linear shape and this linear part **93** extends along the upper surface **65***a* of the crankcase cover **65** in side view. Thus, the length across which air in the exhaust passage is conditioned can be ensured by the linear part **93** and the exhaust air that has passed in the branching pipe **74** can be made to uniformly flow into the left-rear-portion exhaust pipe **76** and the right-rear-portion exhaust pipe **77**. Furthermore, by disposing the linear part **93** along the upper surface **65***a* of the crankcase cover **65**, a space above the crankcase cover **65** can be efficiently used.

The above-described embodiment is one mode of the present invention and modification and application can be arbitrarily made without departing from the gist of the present invention.

Furthermore, the present invention is not limited to the case of applying it to the motorcycle **10** and can be applied also to saddle-type vehicles including vehicles other than motorcycles. The saddle-type vehicles are vehicles that include overall vehicles ridden with the vehicle body straddled and include not only motorcycles (including motorized bicycles) but also three-wheeled vehicles and four-wheeled vehicles categorized as ATV (all terrain vehicle).

The invention being thus described, it will be obvious that the same may be varied in many ways. Such variations are not to be regarded as a departure from the spirit and scope of the invention, and all such modifications as would be obvious to one skilled in the art are intended to be included within the scope of the following claims.

What is claimed is:

1. An exhaust pipe structure for a motorcycle having an internal combustion engine which comprises:

an exhaust pipe having an elongated circular shape and connected to an exhaust port of the internal combustion engine, said exhaust pipe including a branching part that branches into two branch exhaust pipes; and

a muffler connected to each of the branch exhaust pipes;

said branching part being located on a lateral side of a cylinder unit of the internal combustion engine and above a crankcase cover and branching rearwardly into said branch exhaust pipes which have circular shaped upstream end portions, the circular shape of the upstream end portions of the exhaust pipes being partially deformed to form flat walls which are in contact with each other, whereby vehicle body space is effectively enhanced.

2. The exhaust pipe structure for use with a motorcycle according to claim **1**, further providing that the branching part and parts connected to the front and to the rear of the branching part, in the exhaust pipe, are formed into a linear part having a linear shape and this linear part extends along an upper surface of the crankcase cover, in a side view.

3. The exhaust pipe structure for use with a motorcycle according to claim **1**, further providing that the exhaust pipe extends from the exhaust port toward a front side of the motorcycle and then curves rearwardly from the branching part to the branch exhaust pipes; and

a section of the branching part is formed into an elongated circular shape, with a long axis of the elongated circular shape inclined to be parallel to a tangent plane to a curving outer circumferential line passing on an outermost circumference of the curving part of the exhaust pipe.

4. The exhaust pipe structure for use with a motorcycle according to claim **3**, further providing that one of the branch exhaust pipes passes between a pivot plate and a rear shock absorber to extend rearwardly to be connected to one of the mufflers, and the other of the branch exhaust pipes passes between a rear side of the cylinder unit and a front side of the rear shock absorber and then passes between another pivot plate and the rear shock absorber to extend rearwardly and be connected to the other of the mufflers.

5. The exhaust pipe structure for use with a motorcycle according to claim **1**, further providing that one of the branch exhaust pipes passes between a pivot plate and a rear shock absorber to extend rearwardly to be connected to one of the mufflers, and the other of the branch exhaust pipes passes between a rear side of the cylinder unit and a front side of the rear shock absorber and then passes between another pivot plate and the rear shock absorber to extend rearwardly and be connected to the other of the mufflers.

6. The exhaust pipe structure for use with a motorcycle according to claim **5**, further providing that the branch exhaust pipes have at least one bending part in a space that is on the rear side of the cylinder unit, on the front side of the rear shock absorber, above a crankcase, and below an intake system.

7. The exhaust pipe structure for use with a motorcycle according to claim **1**, further providing that the branching part branches in such a manner that the two branch exhaust pipes are juxtaposed in an upward-downward direction.

8. The exhaust pipe structure for use with a motorcycle according to claim **7**, further providing that

the exhaust pipe extends from the exhaust port toward a front side of the motorcycle and then curves rearwardly from the branching part to the branch exhaust pipes; and

a section of the branching part is formed into an elongated circular shape, with a long axis of the elongated circular shape inclined to be parallel to a tangent plane to a curving outer circumferential line passing on an outermost circumference of the curving part of the exhaust pipe.

9. The exhaust pipe structure for use with a motorcycle according to claim **7**, further providing that one of the branch exhaust pipes passes between a pivot plate and a rear shock absorber to extend rearwardly to be connected to one of the mufflers, and the other of the branch exhaust pipes passes between a rear side of the cylinder unit and a front side of the rear shock absorber and then passes between another pivot plate and the rear shock absorber to extend rearwardly and be connected to the other of the mufflers.

10. An exhaust pipe structure for a motorcycle having an internal combustion engine attached to a vehicle body frame, comprising:

an exhaust pipe connected to an exhaust port of the internal combustion engine and provided with a branching part located on a lateral side of a cylinder unit of the internal combustion engine and above a crankcase cover, that branches rearwardly into left rear portion and right rear portion exhaust pipes provided with respective mufflers,

the exhaust pipe extending from the exhaust port toward a front side of the motorcycle and then curving rearwardly to form said branching part which branches rearwardly into said left rear portion exhaust pipe and said right rear portion exhaust pipe, upstream end portions of the left rear portion and right rear portion exhaust pipes being partially deformed to form flat walls which are in contact with each other, and

the branching part comprising an elongated circular shape with a long axis of the elongated circular shape being inclined to be parallel to a tangent plane to a curving outer circumferential line passing on an outermost circumference of the curving part of the exhaust pipe.

11. The exhaust pipe structure for a motorcycle according to claim **10**, further providing that the branching part and parts connected to the front and to the rear of the branching part, in the exhaust pipe, are formed into a linear part having a linear shape and this linear part extends along an upper surface of the crankcase cover, in a side view.

12. The exhaust pipe structure for a motorcycle according to claim **10**, further providing that one of the left rear portion and right rear portion exhaust pipes passes between a pivot plate and a rear shock absorber to extend rearwardly to be connected to one of the mufflers, and the other of the left rear portion and right rear portion exhaust pipes passes between a rear side of the cylinder unit and a front side of the rear

shock absorber and then passes between another pivot plate and the rear shock absorber to extend rearwardly and be connected to the other of the mufflers.

13. The exhaust pipe structure for a motorcycle according to claim **12**, further providing that the left rear portion and right rear portion exhaust pipes have at least one bending part in a space that is on the rear side of the cylinder unit, on the front side of the rear shock absorber, above a crankcase, and below an intake system.

14. The exhaust pipe structure for a motorcycle according to claim **10**, further comprising that the branching part branches in such a manner that the left rear portion and right rear portion exhaust pipes are juxtaposed in an upward-downward direction.

15. The exhaust pipe structure for a motorcycle according to claim **14**, further providing that one of the left rear portion and right rear portion exhaust pipes passes between a pivot plate and a rear shock absorber to extend rearwardly to be connected to one of the mufflers, and the other of the left rear portion and right rear portion exhaust pipes passes between a rear side of the cylinder unit and a front side of the rear shock absorber and then passes between another pivot plate and the rear shock absorber to extend rearwardly and be connected to the other of the mufflers.

16. The exhaust pipe structure for a motorcycle according to claim **14**, further providing that the branching part and parts connected to the front and to the rear of the branching part, in the exhaust pipe, are formed into a linear part having a linear shape and this linear part extends along an upper surface of the crankcase cover, in a side view.

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